

B. Specification

Please amend the paragraphs at page 2, line 20, through page 3, line 5, as follows:

--In the proton-exchange membrane fuel cell, a catalytic reaction presumably takes place at the three-phase interface where all of the polymer electrolyte, the electrode catalyst, and a reaction gas (or liquid) exist. Thus, one of the important factors affecting an electricity generation performance of the proton-exchange membrane fuel cell is the areas of the three-phase interface of: pores serving as supply paths of the reaction gas; the solid polymer electrolyte having proton conductivity; and catalyst particles, at the interface between the polymer electrolyte membrane and the electrode catalyst layers.--

Please amend the paragraph at page 5, lines 6-18, as follows:

--That is, a membrane electrode assembly for a proton-exchange membrane fuel cell according to the present invention ~~provides~~ includes at least a polymer electrolyte membrane and an electrode catalyst layer, wherein at least a part of the polymer electrolyte membrane infiltrates into the electrode catalyst layer, and wherein the polymer electrolyte membrane is formed by polymerizing a composition containing at least a compound having proton conductivity and a compound having activity to an active energy ray, or a composition containing at least a compound having proton conductivity and activity to the active energy ray.--

Please amend the paragraph at page 9, lines 2-13, as follows:

--Fig. 2 is a schematic view showing a bonded surface of the electrode catalyst layer 2 and the polymer electrolyte membrane 1. The membrane electrode assembly of the present invention has such a feature that a part of the polymer electrolyte membrane 1 infiltrates into the electrode catalyst layer 2 to form an integrated structure as shown in Fig. 2. Reference numeral 6 denotes an infiltration portion where the polymer electrolyte membrane 1 is partly infiltrated into the electrode catalyst layer 2. Reference numeral 7 represents conductive carbon supporting a catalyst.--

Please amend the paragraph at page 9, line 26, through page 10, line 8, as follows:

--A catalyst used in the present invention is preferably carried on the surface of conductive carbon. An average particle size of the carried catalyst is preferably small, specifically in a range of 1 to 10 nm. An average particle size of less than 1 nm provides activity that is too high activity for catalyst particles alone, leading to difficulties in handling. An average particle size exceeding 10 nm reduces a surface area of the catalyst to reduce reaction sites, which may deteriorate the activity.--

Please amend the paragraph at page 14, line 20, through page 16, line 14, as follows:

--As a crosslinking agent, at least one multifunctional polymerizable compound can be used by mixing as a copolymer component. Examples of a crosslinking multifunctional polymerizable compound capable of [[carry]] carrying out the

copolymerization include: diacrylates or dimethacrylates of polyalkylene glycol having a molecular weight of 1,000 or less (such as oligoethylene oxide, polyethylene oxide, oligopropylene oxide, and polypropylene oxide); diacrylates or dimethacrylates of linear, branched, or cyclic alkylene glycol having 2 to 20 carbon atoms (such as ethylene glycol, propylene glycol, trimethylene glycol, 1,4-butanediol, 1,5-pentanediol, 1,6-hexanediol, 1,7-heptanediol, 1,8-octanediol, 1,9-nanediol, 1,10-decanediol, and cyclohexane-1,4-diol); multifunctional acrylate or methacrylate compounds having a linear, branched, or cyclic polyvalent alcohol having three or more OH groups such as glycerin, trimethylolpropane, pentaerythritol, sorbitol, glucose, and mannite wherein two or more of the OH groups are substituted with an acryloyloxy group or methacryloyloxy group (for example, trimethylolpropane triacrylate (TMPTA), trimethylolpropane trimethacrylate (TMPTM), pentaerythritol triacrylate (PETA), pentaerythritol trimethacrylate (PETM), dipentaerythritol hexaacrylate (DPHA), and dipentaerythritol hexamethacrylate (DPHM)); multifunctional acrylate compounds having a molecular weight of 2,000 or less and having the above-mentioned polyvalent alcohol wherein two or more of the OH groups are substituted with an acryloyloxy-oligo(or poly)ethylene oxy(or propylene oxy) group; multifunctional methacrylate compounds having a molecular weight of 2,000 or less and having the polyvalent alcohol wherein two or more of the OH groups are substituted with a methacryloyloxy-oligo(or poly)ethylene oxy(or propylene oxy) group; aromatic urethane acrylate (or methacrylate) compounds such as a reaction product of tolylene diisocyanate and hydroxyalkyl acrylate (or methacrylate) such as hydroxyethyl acrylate; aliphatic

urethane acrylate (or methacrylate) compounds such as a reaction product of aliphatic diisocyanate such as hexamethylene diisocyanate and hydroxyalkyl acrylate (or methacrylate) such as hydroxyethyl methacrylate; divinyl compounds such as divinylbenzene, divinyl ether, and divinyl sulfone; and diallyl compounds such as diallyl phthalate and diallyl carbonate.--

Please amend the paragraph at page 17, lines 20-24, as follows:

--In particular, a (meth)acrylate derivative having a phosphate group on a side chain can be suitably used. [[This]] For example, ~~is the trade name~~ Phosmer M (acid phosphoxy ethyl methacrylate), which is a commercially available product from Uni-Chemical Co., Ltd., can be used.[[])]]--

Please amend the paragraph at page 19, lines 22-24, as follows:

--The coating liquid prepared [[thus]] accordingly is coated on the electrode catalyst layer to be infiltrated into the electrode catalyst layers.--

Please amend the paragraph at page 24, lines 3-19, as follows:

--Electron beams, X-rays, and gamma rays are preferable because the ray reaches inside of the stack of the electrode catalyst layers and the coating liquid and because the cost of the irradiation equipment thereof costs is relatively low, thereby allowing a reduction in process the cost of the process. Electron beams and X-rays are particularly preferable because irradiation of the rays is easy and [[its]] the cost is low.

Electron beams are most preferable because of high polymerization efficiency of monomers through irradiation. Examples of an electron beam source include various electron beam accelerators such as a Cockcroft-Walton accelerator, a Van de Graaff accelerator, a resonance transformer accelerator, an insulated core transformer accelerator, a linear accelerator, a dynamitron accelerator, and a high frequency accelerator.--

Please amend the paragraphs at page 25, lines 15-27, as follows:

--Of the energy rays, electron beams are particularly transmitted well through organic substances and therefore ~~permeat~~ permeate to the inside, thereby providing an electrolyte membrane sufficiently bonded to the electrode catalyst layer.

Further, if required, a heat treatment may be performed on the electrode catalyst layer coated with the coating liquid during irradiation of an active energy ray and/or the formed electrolyte membrane after. Further, after forming the polymer electrolyte membrane, the membrane may be subjected to a treatment such as hot pressing in order to enhance the bonding between the layers and the membrane.--

Please amend the paragraphs at page 26, line 15, through page 27, line 11, as follows:

--Carbon paper (TGP-H-30, available from Toray Industries, Ltd.) having a thickness of 0.1 mm and subjected to a water repellency treatment was used as a diffusion layer. A paste prepared by sufficiently mixing 1 g of carbon carrying a 60 wt.% Pt-Ru catalyst (Pt : Ru = 1 : 1, atomic ratio) (available from Tanaka Kikinzoku Kogyo K.K.) and 5 g of a 5 wt.% Nafion solution (available from Sigma-Aldrich Co.) was used as an

electrode catalyst layer of an anode side (negative electrode). Carbon paper was coated with the catalyst paste to a predetermined thickness using a bar coater, and then was dried under a reduced pressure at room temperature.

Carbon paper subjected to the water repellency treatment was also used as a diffusion layer of a cathode side (positive electrode). A paste prepared by sufficiently mixing 1 g of carbon carrying a 60 wt.% Pt catalyst (available from Tanaka Kikinzoku Kogyo K.K.) and 5 g of a 5 wt.% Nafion solution was used as an electrode catalyst layer of an anode side (negative electrode). Carbon paper was coated with the catalyst paste to a predetermined thickness using a bar coater, and then was dried under a reduced pressure at room temperature.--